Innovation, cities and place: an empirical study of the knowledge system in Vancouver and its place on the Pacific Rim

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Key Points

Human capital intensive clusters emerged surprising early in a number of technology fields in Vancouver (Canada), but they largely failed to develop beyond entrepreneurial rent seekers. We discuss this in the light of Vancouver's international economic spatial position. Vancouver appears to occupy a strategic Canadian innovation pivot point position on the Pacific Rim.

Abstract

As a generalization the innovation systems literature has downplayed the overall physical geographic setting of particular places and the connections between cities in national or international urban systems. This paper examines the innovation history of a few of Vancouver's peculiarly human capital intensive clusters noting how the isolation with no nearby cities and its connectedness (a Pacific gateway point) appear to have shaped its trajectories. This analysis begins to make a few sketches of how place and innovation can come together emerging from a 10 year study of innovation clusters and cities in Canada.

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Introduction

Virtually all innovation studies have been carried out in industrialized countries, and most of these studies have been carried out in Europe and eastern North America. These studies have induced governments to focus their innovation policies on promoting innovation in what is perceived to be high value sectors – i.e. high technology manufacturing, and in places where there are intensive agglomerations of industrial activity. One feature of densely populated mega-regions is that agglomerations of industrialized activity (which in Europe can stretch across national boundaries or in the USA across state borders) is that they have lines of communication within themselves and among the different agglomerations that radiate out in all directions. Even port cities in this context have lines of communication that link them to several agglomerations in their hinterland.

But there is another model of development; one that is typically found in nations which have a more recent history of settlement and industrialization, or which have unusual geophysical characteristics that have in turn fashioned a different geography of industrialization. In these cases development can take place in a linear fashion as industry and thus innovation follows a transportation route. Western Canada is an example of this where development proceeded west along the transcontinental railway line as settlers moved in from Europe and eastern Canada. There are similar models in Australia (sea trade along its east coast) and with some differences, the western coast of the US and Chile (mountain barriers).

Do policies that promote innovation in what could be described as a two-dimensional economic space work in a one-dimensional situation? Or should there be a different set of innovation policies that take into account the transportation and communication constraints created by a single corridor? What are the implications of this unique geo-economic situation on innovation in these one-dimensional corridors, and what unique policies might be required?

The work for this paper stems from 10 years of research on the Canadian innovation system which has investigated in comparative fashion the development of clusters and city centric innovation systems. This paper has evolved out of thinking about the Vancouver example with an awareness of the greater project's results. Detailed specific analysis of Vancouver's innovation system has been published elsewhere (Wixted and Holbrook forthcoming) but that paper left open the question of how being on the Pacific Rim has influenced the history of Vancouver's innovation system. Drawing upon a wide range of existing research and our own work we try to move one step closer to a framework for discussing the emerging development of the Pacific innovation structures. A conclusion of this research is that while geography matters policy needs to be active. Innovation policies and the development of innovation systems, regardless of scale, must be pursued at the city level, perhaps even eclipsing those policies developed by national

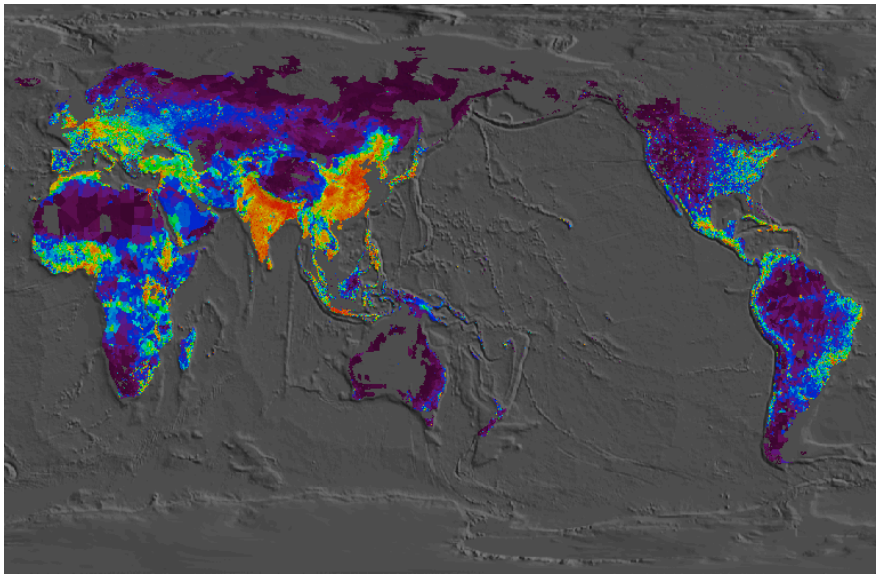
or sub-national governments. The evidence presented here also supports the inheritance view of clustering (Klepper 2001) and begins to suggest that policies that support early career stage professionals gaining business experience not just academic education may be quite important.

The dimensional space of 'innovation systems'

A huge literature now exists on the concept of innovation systems, with the focus of the studies gradually narrowing from nations (Lundvall 1992; Nelson 1993; Freeman 1995; Edquist 1997 and Sharif 2006), to regions (Cooke 1998), clusters (OECD 1999 and 2001) and now to cities (Florida 2002). But this narrowing of the spatial focus often does so by continuing to ignore the larger scale phenomena. From a policy perspective then, it has become increasingly unclear what impact the different level of analysis should have.

One aspect of the innovation systems literature which has been rather conclusively shown is that little of it problematizes system boundaries (Wixted 2009). This leads to an initial contention of this paper, that the population and economic landscape which form the milieu of academic research has influenced the research agenda to a greater extent than is generally acknowledged.

Fig.1. Adjusted World Population Counts 2000.



Source: Center for International Earth Science Information Network (CIESIN), Columbia Uni-

versity; and Centro Internacional de Agricultura Tropical (CIAT). 2005. Gridded Population of the World Version 3 (GPWv3): Population Grids. Palisades, NY: Socioeconomic Data and Applications Center (SEDAC), Columbia University. Available at http://sedac.ciesin.columbia.edu/gpw.

While Fig 1 (above) highlights both the mega-population regions of Western Europe, Eastern United States, East Asia and South Asia, it also reveals some other information of significance. Canada, Australia, the western United States, Chile and even western Russia have regional structures that are rather linear and in some cases best described as an archipelago of populations. The latter designation can best be applied to Australia and Canada (east and west of Ontario-Quebec).

Much of the innovation systems literature emanates from Europe where populations centres form densely packed regions with major competing centres on all four points of the compass and in relatively close proximity for many key cities. Although there has been a both a geographical turn (Martin 1999) and a relational turn (Yeung 2005) in economic geography; the first emphasizing place and history, while the second emphasizing the relationships between actors in a particular locality - many of these locations are within what can be described as a two dimensional system. Yeung, for example identifies the relational turn stating:

> Recent theoretical and empirical work in economic geography has experienced what might be termed a 'relational turn' that focuses primarily on the ways in which socio-spatial relations of economic actors are intertwined with processes of economic change at various geographical scales.(2005:109).

Earlier, in what is now argued by some to be an 'outdated' (see Barnes 2003) analytical emphasis in economic geography prevalent in the 1950s and 1960s was that of central places in two dimensional space. The emphasis was on the development of 'central places' (cities) and their hinterlands (see for example Christaller 1966). The key question was why did places develop as central and larger and some remained small villages? Christaller put it in these terms:

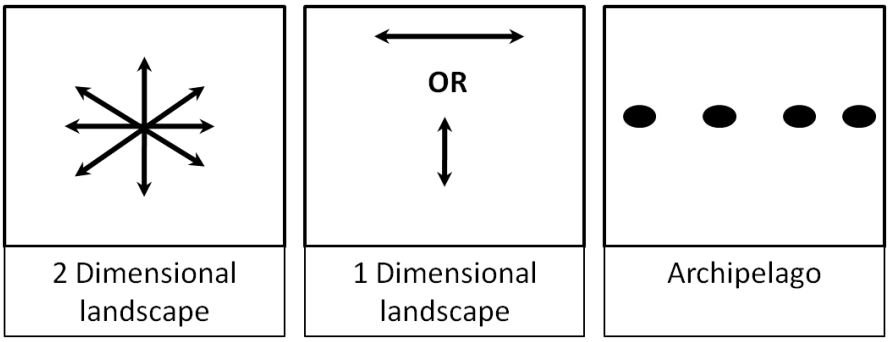
> Gradmann has called the chief profession of a town, namely, 'to be centre of its rural surroundings and mediator of local commerce with the outside world'. As one might think, this chief profession affects the small country towns which are really exceptions, being nothing more than the centres of their rural surroundings. But it also affects in the same way the larger towns, not only in respect to their immediate vicinities, but also in regard to their places in systems of many smaller towns (1966:16).

While Krugman and others have returned to these older ideas the innovation system scholars have never adopted the perspective to question the inter-relationships and interdependencies between regions, preferencing a focus on the history, local context and actor dynamics of specific places (cities, regions, cluster, nations). Thus, a large percentage of cluster studies for example, ignore the spatial distribution of clusters or the interconnections between them (as is argued by Oinas and Malecki 2002; Bunnell and Coe 2001; and Wixted 2009). However, as the context for most of the current studies is the densely populated mega-regions of the Western Europe and the Eastern United States, it would not be too

much of a stretch of the imagination to suggest that the two dimensionality of economic space forms the unconscious presuppositions of the research questions. The individuality of place is an interesting question if there are many different localities with a given geographic distance than 'could have' (but didn't) given rise to high rates of innovation. But such a context as noted above does not fit the geographical context of everywhere. If across large geographical distances there were only a few major centres to start with, then the focus needs to be different.

One hundred years ago the geographic positions of Australian and Canadian city innovation systems were not too different from their modern realities as both were systems of ports of a fashion. Of course each system has different historical, physical and contingent factors. Australian cities, being set within an island nation with poor water supply in its interior, are all seaports providing an administrative and service bridge between the high value produce inland and the world's markets. Canada's cities, being landlocked, were different. They were established at intervals, often at major river crossings, along the first Canadian transcontinental railway, the Canadian Pacific railway (CPR), but in each case they were there to aid the trans-shipment of commodities. Until the arrival of jet aircraft in the mid to late 1950s, Vancouver[2] was primarily accessible by sea or rail as even road access was difficult. So instead of one model of geography we should have at least three.

Fig. 2. Different dimensions of city system configurations



[2] Although Seattle is relatively near physically, there has been little interaction between the two cities. Initially it was because both were competing in the same resource businesses. Seattle branched out into high-tech as a result of WWII and Cold War investments by the US military which did not spill over into Canada. Finally, the result of heightened border security on the part of the US has led to a throttling of transactions between the two cities – e.g Microsoft has establishment a base in greater in Vancouver to connect with Canada and easier immigration. As a result Vancouver has had to look eastwards to the rest of Canada rather than south.(with the exception of course, of the film industry).

There is little reference in the work on innovation systems to states where populations are either linear or broken up. We could use words such as; periphery, gateways and others but each of these has complications. "Periphery" or semi periphery (Wallerstein 1976, Boreham et al. 1989) are used in reference to places that are distant from the international economic centres (i.e. Western Europe and the Eastern USA) but this can emphasise distance from the centre while not illuminating the urban structure dimensions. It also de-emphazises the network bridging role that such places can play. "Gateways" is also somewhat problematic as it is traditionally emphases transport, particularly multi-modal (sea, rail, truck) transshipment rather than innovation (Rodrigue *et.al*. 2009). In some cases "entrepôt" (Phillips 2002) is useful where foreign investment drives local activity, particularly for foreign sales, but again as we shall show for Vancouver this doesn't capture the essence of its innovation functions.

The problem with our language of 'innovation systems' is that we want to think of them as a unified structures and forget that a higher level notion of systems requires better ideas on sub-level configurations. The results of the Innovation Systems Research Network over the years could be used to describe the innovation functions of various cities. Saskatoon is an entrepôt for biotechnology (Phillips 2002), Calgary as a technology services hub for the oil and gas production assemblage (Langford et.al. forthcoming) and Vancouver as a location for high human capital intensive activities from movies to fuel cells. However, we can go further and describe the degree to which cities are linked to a broader suite of regional economic activities. Saskatoon is internationally connected in a few resource-based industries, Calgary is highly integrated with its sub-national regional production system based on the petroleum industry, but Vancouver is increasingly operating as a separate economy dependent upon a series of sub-economies that include; legitimate economic activity, as well as the black economy (drugs trafficking and cash transactions) and what is locally known as the "red" economy (Chinese investment in property)[3].

However, within the framework of the existing literature, it is not straightforward to sketch hypotheses on the expected innovative and technological or knowledge intensive industries that might be found in particular cities. The literature of the Marshall-Arrow-Romer[4] versus Jacobs (MAR-Jacobs) debate helps little as very few papers take any account of the macro-geographic urban system setting, apart from perhaps city size. In recent years innovation systems research has begun to take a more sophisticated approach to the multi-scale nature of geogra-

[3] There are a number of terms that can be used in this matter; underground (see BC Stats 1994), black (Thomas 1999) or hidden (Frey and Pommerehne 1984). Drugs have been estimated to be worth nearly 3 per cent of the provincial economy (Easton 2004), and cash also around 3 per cent in 1994 (BC Stats 1994), and though these would be intersecting sets they are not duplicates.

[4] Simply put the MAR argument is that innovation benefits from enviroments that specialized (typified by industrial towns), while Jacobs argues is that cities in all their industrial and cultural diversity are better for innovation.

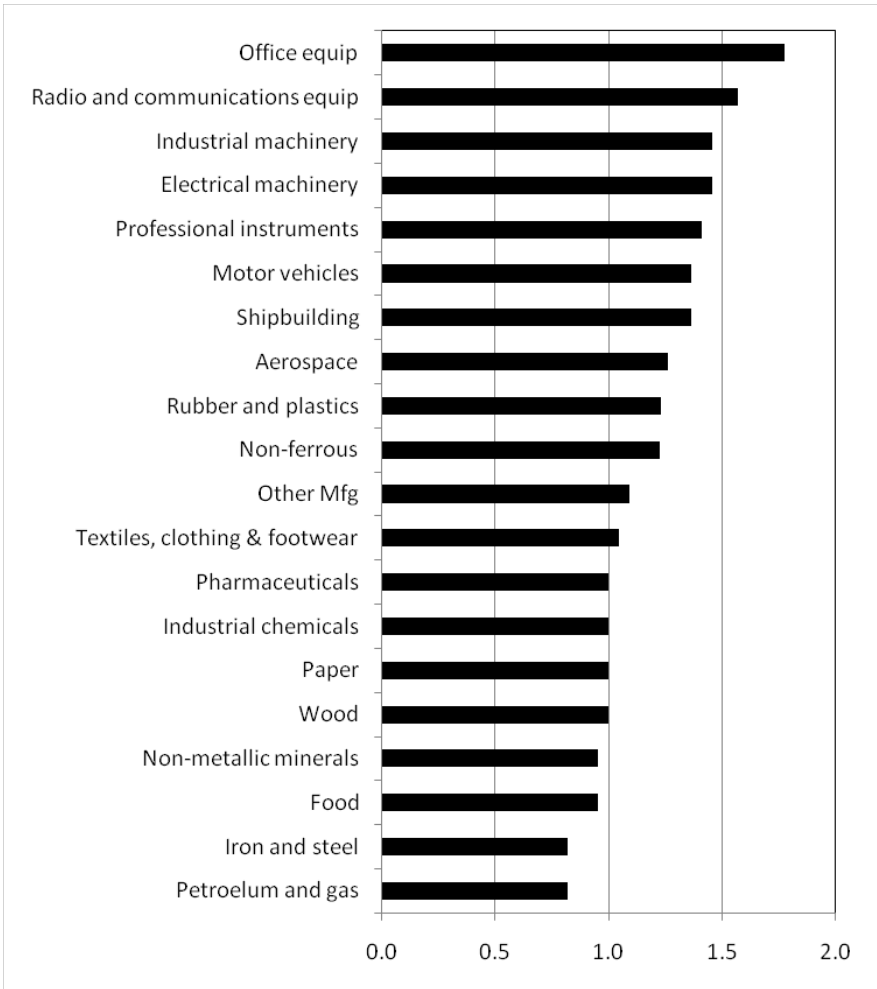
phy; incorporating national, regional and city levels (with cluster studies stretching across multiple layers). However, apart from a focus on the internationalisation of R&D centres (OECD 2008) there has been too little work exploring the multi-spatial linkages across these scales and spaces. Carlson (2006) for example states:

> 'in view of the fact that most studies of innovation systems focus on national innovation systems, it is not surprising that little direct evidence is found that innovation systems are becoming global. The main focus in this literature is on institutions at the national level. But national institutions may influence innovation systems at regional, sectoral or technological levels differently. However, at these lower levels there has been little work done with a view toward internationalization of systems (as distinct from corporate innovative activity). Also, not all institutions are national. For large firms, national institutions may be most important, while for small and new firms, subnational institutions may also be important' (2006: 65).

This is beginning to change with, for example, Wixted (2009) mapping the international flows of components in a range of complex products for the period between 1970 and 2000. However, that study only focused on the interactions between national clusters and using large scale multi-country input-output modeling techniques. The book argued that while some industries are truly global (aerospace and automobiles) others are more restricted to continental (and smaller) trading areas.

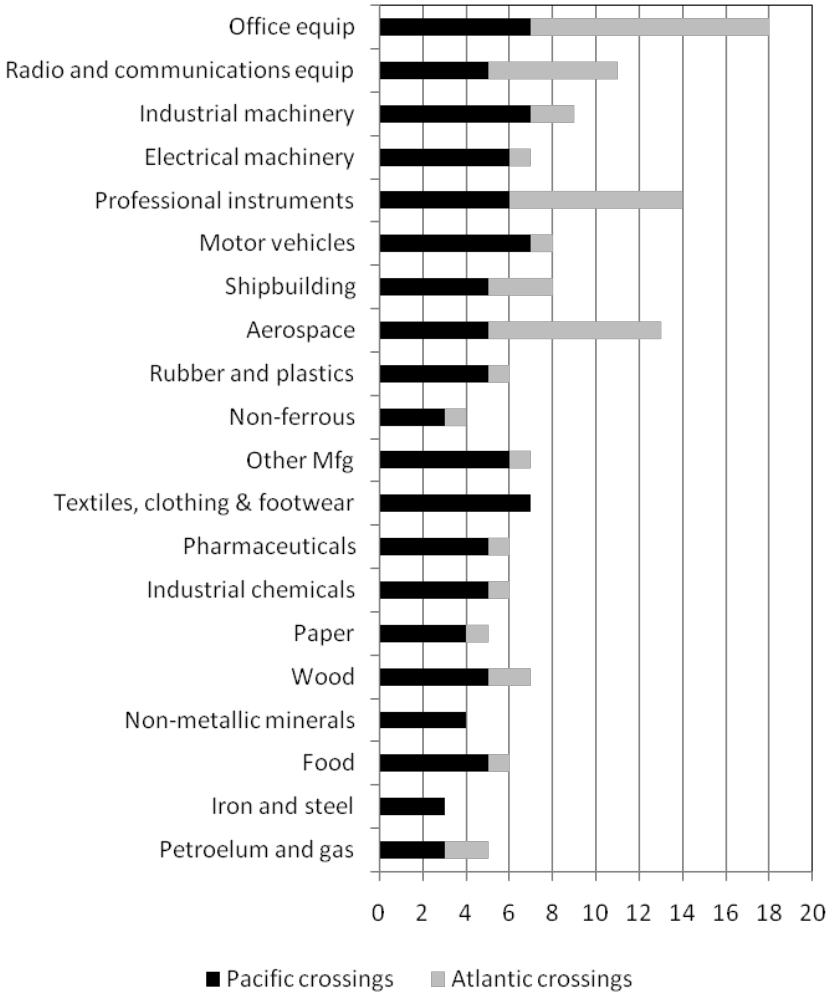
In a more recent paper Wixted (forthcoming) has looked at trade flows for twenty classes of manufactured products. Based on the year 2000 and significant trade flows, although there are no clear breaks there appear to be three distinguishable sets of industries. Some are truly globally connected while others are only barely connected (Fig 3). Interestingly, trans-Pacific connectivity is far greater than trans-Atlantic connectivity (Fig 4).

Fig. 3. Significant trade links by industry as ratio to the number of economies in the model



Source: Based on work for Wixted (forthcoming).

Fig. 4. Trans-Pacific and Trans-Atlantic significant trade links by industry



Notes: Europe to Asia links are excluded from the analysis but this is not a large number.
Source: Based on work for Wixted (forthcoming).

Except for industries such as aerospace, professional instruments, radio and communications equipment and office equipment, Pacific trade crossing are of much more importance than trans-Atlantic ones. This is somewhat surprising as the 'buzz' is between Europe and Eastern North America as witnessed through either air line flight data or internet traffic flows.

The Canadian National Innovation System

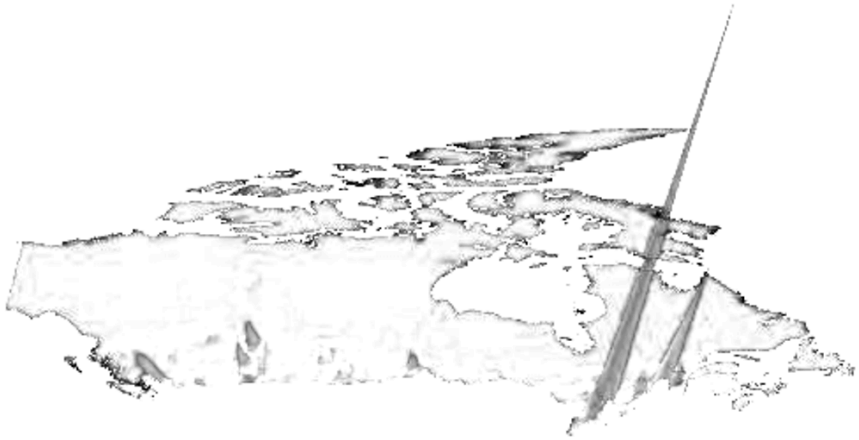
The NIS literature emerged from evolutionary economic theory and joined with more mainstream science, technology and innovation policy analysis. Analyses of RIS by contrast, came initially from regional science and economic geography, as well as institutional economists and sociologists (see discussion in Holbrook and Wolfe, 2000). But what is a region? What are the characteristics one should look for, in order to talk about regional or even local systems of innovation (cities) instead of a national approach? Regions are often defined in terms of shared normative interest (cultural areas), economic specificity (mono-production systems) and administrative homogeneity (governance areas). To these must be added other criteria, such as a non-specific size (except that of being part of a nation state); identifiable cultural or industrial mix; an ability to be distinguished from other regions in terms of these criteria; and, possession of some combination of internal cohesion characteristics (Cooke, 1998).

For federations, the national innovation systems (NIS) concept should be understood as being a set of more complex relationships than that of a centrally-administered nation, since there are often provincial/state level institutions and actors paralleling national level institutions and actors, with some policies or powers under provincial control, and others under federal control. Canada is one of the few true economic and social (as well as political) federations in the world. In the OECD, only Australia, the US and Germany come close to the unique structure and socio-economic features that exist in Canada. Thus, unlike most nations in the OECD, and other parts of the industrialized world, the Canadian NIS is different. A key element of the Canadian federation is the allocation of most economic powers to the national government and the assignment of social responsibilities - particularly health and education – to the provinces.

In Canada, the NIS is regionalized; the Ontario/Quebec economy is not the same as the BC or Prairie regions. Indeed, Canada is a country of metropolitan "islands": Vancouver, Calgary, Toronto, Montreal, etc. National statistics are heavily weighted by the industrial activity that takes place in the Windsor – Quebec City corridor. Thus for Canadian policy makers there is an important question: what are the boundaries of a functional system of innovation and what determines its viability? How small or large is a region?

In economic terms Canada is a thin ribbon of settlement, mainly within 200 km of the US border. In eastern Canada, the major cities are closely linked to the eastern US economy, and thus are the northern periphery of that large two-dimensional economy. Western Canada is quite different. The major cities are strung out along the Canadian transcontinental railway system like pearls on a necklace. Indeed the railway was for all of them a major factor in their establishment and development in the late nineteenth and early twentieth century. These cities are separated by hundreds of kilometres of sparsely settled land – farms, ranches and forests.

Fig. 5. Canadian GDP by location



Source: Nordhaus 2006.

Holbrook and Wolfe (2000) have argued, at least in the case of Canada, in order to understand the NIS, one must first understand the RIS. Is the Canadian NIS the sum of a number of RIS, based either on economic regions or provincial boundaries? In the Canadian context this sum is distorted by the wide variation in sizes of the regional systems – national level data (and the ensuing analyses) of the Canadian system of innovation are heavily biased by the economic activities occurring in the two major industrialized provinces, Ontario and Quebec. In most developed nations, innovation, science and technology policies are formulated by the central government, yet most innovation takes place locally. Thus nation-wide innovation policies may not affect each region equally, and could conceivably be counterproductive.

In May 2001 a network of researchers drawn from the five regions of Canada: Atlantic Canada, Québec, Ontario, and Western Canada launched a project "Innovation Systems and Economic Development: The Role of Local and Regional Clusters in Canada", that examined the impact and importance of cluster-driven innovation in Canada (Holbrook and Wolfe, 2005). This research network, the Innovation Systems Research Network (ISRN), investigated how local networks of firms and supporting infrastructure of institutions, businesses and people in communities across Canada interact to spark economic growth. When the analyses of the Canadian NIS went a step "down" from the national level to a regional one, social issues emerged more clearly, and the importance of communication and in-

teraction were highlighted. The innovation systems studies of the flows of knowledge, and how knowledge is created, have realized the importance of the interaction between the different actors (particularly users and producers of of knowledge and innovation – see e.g. DeBresson 1996), mutual trust (Maskell and Lorenzen 2004 on the benefits of clustering) and of course proximity needed to facilitate these flows,

While previous studies of innovation systems and economic development have been limited to individual regions, this project analyzed how the growth of clusters contributes to economic growth and development within a number of regions across Canada. Research focused on more than 25 clusters across the five regions in newly emerging knowledge-intensive areas (ie: information and communication technologies (ICT), wireless, new media and biomedical,) as well as in more traditional sectors (ie: manufacturing, wood products, food and beverage, automotive and steel). Studies on IT, biotech, new media, and wireless clusters were carried out in at least three separate regions, to get an understanding of the regional differences across the country. Recognizing that, in Canada, the manufacturing sector is concentrated in eastern Canada, studies in Ontario/Quebec also included automobiles, aerospace, and food products among others.

Arguably, in Canada, some provincial boundaries, such as those between Saskatchewan and Manitoba, or among the Maritime Provinces (the localist business innovation provinces), are artificial in terms of innovation systems. Canadian RIS can extend beyond provincial boundaries, or in some cases, such as the Ottawa and greater Toronto RIS, be contained within one province. Indeed in the more successful regions, from the point of view of innovativeness the RIS can be subdivided into local systems of innovation (LIS), which are usually based in individual cities . Table 3 gives a possible taxonomy of local systems of innovation in Canada. The structure is derived from Cooke (1992 and et.al. 2004). Grassroots is defined as where the cluster governance characteristics are self-generated. Networked governance infers that multiple tiers of actors come together particular geographic points to act on the innovation system. Finally, dirigiste is defined by actors primarily above and beyond the local being the principal motivators of change.

Table 1. Canadian Local (metropolitan) Innovation Systems

Business innovation dimension	Governance structure		
	Grassroots	Network	Dirigiste
Localist	St. John, New Brunswick St. John's, Newfoundland & Labrador	Halifax	Québec City
Interactive	Saskatoon Winnipeg	Calgary Edmonton Victoria	

Globalized	Ottawa	Toronto Vancouver	Montréal

Source: Holbrook, 2006

The study methodology

Why should Vancouver be a major centre of innovation in Canada? More particularly, why should it be host to a number of human-capital intensive clusters? The study of Vancouver was based on an examination of human capital based economic activities that are important to the region that are mostly a little unexpected in a city so far from other major population centres. The five activities chosen were:

- fuel cells (predominantly based on hydrogen technologies) utilizing interviews and published papers based on 19 in-depth interviews;
- bio-pharma (a range of firms creating human health oriented biotechnologies or traditional pharmaceuticals) based on 31interviews;
- motion pictures based on extant literature;
- new media (mainly the electronic games sector) based on 73interviews; and
- wireless technologies based on 36 interviews from a previous project and extant literature.

The second wave of ISRN research foccused on the MAR-Jacobs debate which is couched in terms of intra-city spillovers either within or across industries, but we can use the material to investigate the role of Vancouver on the Pacific Rim. We used the survey responses to test the perceptions of industry participants on the source of important inputs. Agglomeration processes worked out in the evolution of centripetal vs centrifugal forces: the logic here is that the start up time of clusters can show whether there are centripetal cost pressures at work which have delayed the start up times of clusters. For example, a technology industry may have started up somewhere else in the 1980s but only got going in BC in the late 1990s. This would be a primary indicator that industry evolution was expanding the geographic frontiers and creating a space for new players.

More traditional indicators of innovation such as R&D expenditures and results from conventional (OECD-type) innovation surveys were not used. There are important reasons for not weighting such information highly for Vancouver. Data on R&D expenditures is not published on a city basis by Statistics Canada, thus data at the provincial level would have to be used. More importantly, there is an unavoidable built-in bias towards central Canada in Canadian innovation surveys due to the way the samples have to be constructed.

Vancouver in particular has very little manufacturing compared to the national average and as our analysis (below) reveals Vancouver's enterprise demography is weighted more towards smaller businesses.

Table 2. Cluster interviews

Cluster	ISRN 1	ISRN II
Fuel cells		19
New Media	21	10
Wireless	72 (Alberta & British Columbia	1
Bio-Pharma	32	4
Miscellaneous		13
Total Interviews	125	47

Analysis

Vancouver is mid sized city (2.5 million population) on the western fringe of the North American continent. Statistics Canada (2003) reports that Vancouver has an industrial diversity very similar to Toronto although having a significantly smaller-population. The key question to be addressed by this section is whether the clusters started early and grew more or less autonomously via say the inheritance model of cluster development or whether their development has been greatly influenced by external events or even transplanted from elsewhere.

It is not sufficient to examine the MAR- Jacobs questions of "spill-ins" (as one might call the benefits flowing into particular activities from other firms in the same city or the diversity of the city itself), but also the labour markets for these human capital intensive clusters and the start-up conditions Table 2).

Table 3. Industry start-up timeline

Cluster	Vancouver / BC origins	Global Origins
New media	1980s	1980s (California
Bio/Pharma	1981	1976
Fuel cells	1980s (Ballard Power)	1950s (space program) / re-emerged 1980s
Wireless communications	Late 1930s	1930s
Motion pictures	1980s	LA - 1900s (1920s – beginning of the boom – Storper & Christopherson 1987)

Source: Wixted and Holbrook (forthcoming)

Fuel Cells.

Of all the human capital intensive activities, fuel cells is the smallest and most specialised in terms of spillovers. Although it has benefits from R&D capital from outside the region, it is significantly an undiversified cluster as it relies on local R&D facilities and access to near-local talent at the University of Victoria (Holbrook et.al. 2010).

Bio/Pharma.

The prime characteristic of the bio/pharma cluster in Vancouver is one largely of IP rent seeking. For example it doesn't have the critical mass of important centres east and south but companies do have strategies for managing the construction of value in Vancouver. In response to the question 'how does your firm benefit from being located in this particular urban region with its mix of firms/institutions' one business leader responded:

"*To a limited extent the company does benefit from ideas generated in the local milieu and the skilled people that reside here. But all these things are comparative. Compared to being in Saskatchewan, in Saskatoon, I would think probably yes. Compared to being in the Bay Area, absolutely no. We're here because some groundbreaking science was done here, and the scientists who created those innovations decided it was worthwhile trying to commercialize them, hence we're here. We get enormous benefit from continuing to work with them. In the community there's a reasonable level of managerial expertise. It's not terribly high; there's not a lot of people, but there are a number. And there are some people to go to for various sorts of help. There is a pool of skilled scientific staff, but not an enormous number because we have a relatively small biotech community here. So, yes, there are advantages compared to being out of the loop completely"*

One interesting insight came from another business executive:

"*We mainly collaborate with Australia, New Zealand, California, Montreal and North Carolina*"

So in Bio-Pharma the specific location of Vancouver has helped it survive but has been a barrier to its development beyond a certain size.

Wireless.

The wireless cluster has had a long and varied path in Vancouver relying on investment from outside the region as well as, for a time, an innovative, provincially owned telephone company. Today the cluster has close ties with the new media cluster. This closeness is highlighted by the very recent amalgamation of the two industry associations WinBC (for Wireless) and New Media BC into DigiBC, an organisation representing approximately 22,000 employees and 1300 companies.

Motion Pictures.

What is interesting abut the story of Vancouver and motion pictures is there has been a very traditional split between foreign film development in Vancouver and Canadian film industry activities in Toronto (Coe 2001). This trend has been weakening in more recent years. The dependency of Vancouver on external interaction is seen by the need to continually reassess the tax credit status of foreign films (primarily out of the USA). Coe for example, highlights the closeness of Vancouver and Hollywood products:

> As a location, Vancouver was extremely well placed to benefit from the opportunities being created by the on-going vertical disintegration of the Hollywood studios. The city is close to Los Angeles (2.5 hours' flying time), provides an enviable 'west coast' quality of life, is in the same time-zone thereby allowing easy co-ordination of activities between the two centres, has a mild climate which allows all-year-round filming and offers a large range of different scenic locations within 1–2 hours' drive of central Vancouver (2001: 1760).

In 2009 this industry in Vancouver experienced significant economic turbulence during the global financial crisis, but seems to have nevertheless attracted significant investment.

New Media.

The new media specialisation and diversity pattern is summed up excellently by the following quote by a manager in a major new media producer in response to a question regarding the major benefits of Vancouver.

> *"Vancouver is a beautiful city—a draw for recruits. Sea to sky [a reference to the seaside highway between Vancouver and Whistler] Has a lot of amenities. Great place to make video games because there are lots of companies that make video games. Very incestuous here ... Hollywood North helps. Strong film and television. Cross fertilization, we use those*

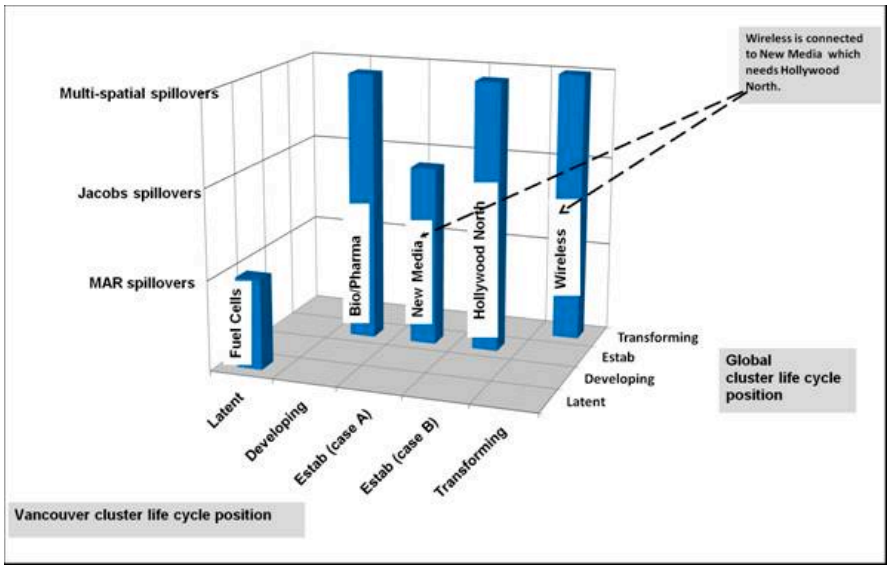
professionals. Great educational institutions that produce high caliber potential hires. On the pacific rim gateway including to the east. …. It is cheaper to develop here than in the US. It was the case, anyway for many years."

In this one quote one can see that the advantage for Vancouver is simultaneously local, diverse (interactions with motion picture industry) and translocation (given references to being on the Pacific Rim as well being a gateway to the East – Toronto and Montreal). The reference to cross-fertilization is important. This is an explicit acknowledgement of the value of clustering among both competitors and similar, but not necessarily competitor industries (i.e. new media and motion pictures)

In 2009 this industry in Vancouver also experienced significance economic turbulence during the global financial crisis. However, based on the significant capital sunk costs in the region and the history of startup entrepreneurship it is expected that this cluster will show resilience to the turmoil.

We have also summarised our finding on the local industry lifecycle position as it is today relative to the global situation.

Fig. 6. Current lifecycle positions of Vancouver's clusters



Source: Wixted and Holbrook (forthcoming)

Three phenomena should stand out. First, apart from the example of motion pictures the Vancouver cluster started early globally, in one case (fuel cells) leading the world to re-examine the technology. It would suggest that mostly these are

not spin-out clusters but have there own independent trajectories. Second, apart from fuel cells all the clusters rely on a diversity of spillovers for inputs that at the very least are local but in many cases stretch across the North American continent both east and south. Though not presented in depth here the outputs of these clusters are marketed globally. Lastly, we can suggest that there something west coast about many of these activities which have a distinctly mid to late 20th Century origins in comparison to east coast US manufacturing or business services; which in Canada are based in Toronto and Calgary but not Vancouver.

The evidence can be summarised as follows.

MAR – Jacobs. While there is some evidence for cross industry spillovers the strongest evidence is for multi-spatial spillovers in terms of inputs and for a global outlook in terms of sales.

Agglomeration – the lifecycle evidence suggests that all the clusters are mostly of long standing in the Vancouver region and with the exception of the major motion picture activity all clusters have indigenous roots, suggesting that they are not spin-outs from more innovation intensive regions.

So why has Vancouver been able to be early or at least only slightly behind the frontier in these talent based activities?

Discussion: Vancouver on the Pacific

It issuggested in this paper that a dominant factor in the emergence and continuance of Vancouver is its position on the west coast of North America, as well as being the most accessible Canadian airport to Asia and being in the same time zone as California seem relevant.

In contrast to the current regional science philosophy, it was previously argued that transport systems were vital. The development of cities and regions has generally been associated with the development of transport. A good description of this association has been provided by Anderson's (1985) overview of European urban history where the fortunes of places have been shaped primarily by their position in a transport system. (O'Connor and Scott 1992:240).

Prior to the arrival of the Boeing 707, Vancouver was where the trans-Canada rail line had placed it – literally and figuratively at the end of the line. It was simply an intermodal (rail/sea) transfer point and the northwest edge of the North American continent. At that time, Calgary was a bigger destination for air passengers in the early 1950s (Natural Resources Canada, 1957). This changed with the introduction of the first mid-sized long haul aircraft (the 707s could safely fly over the Rocky Mountains) and today the Boeing 777 and the Airbus 340 are specifically designed to fly the ''thin'' routes and thus continue to change hub positioning. The change in aircraft has been assisted by changes in navigation and air

route administration involving trans-polar routes which has reduced flying times between Europe and North America, and from the Asia Pacific region to both North America and Europe. A second technical shift has involved the refinement of engine performance, along with management of passenger and freight loads, to create 13–15 hour point-to-point services. Extended range 747s, 777s and A340-500s have made it possible to fly directly between places like Chicago and Hong Kong, New York and Hong Kong and Los Angeles and Singapore. Taken together these changes have helped change the pattern of passenger traffic in North America.

Today, Vancouver is a major gateway city, being the fourth largest seaport in North America and more importantly for its human capital based activities it continues to develop as a major airline hub.

> The ocean rim character of the region's settlement provides another reason for the growth in air travel. In effect, the region is a series of nodes around the Pacific Ocean, with strong, outward looking commercial activities, and in many cases, very limited local hinterlands. Vancouver, Los Angeles, Sydney, Singapore, all share an unusual characteristic in that they have large concentrations of population, but with limited development of an inland hinterland (O'Connor and Scott 1992: 244).

Thus, aircraft technology and preexisting settlement patterns form important feedback loops that enhance or diminish a city's ability to attract traffic and talent.

> In the modern age there are co-evolutionary processes between aircraft technology, airline traffic management and city development, such that once established a major centre cities themselves become major draws of people which reinforces their status which then feeds back to drawing more people. It would seem that the character of the global geography of airports is shaped by the forces associated with global city development. That means the continuation in the significance of the global cities will maintain the dominant role of a few very busy airports in the global network (O'Connor 2003:84).

Different innovation systems around the world have different human capital attributes and different technological advantages and their geographic positions differ markedly, but all three characteristics matter. Vancouver is almost unique as a local innovation system (LIS) in North America: it is not self-contained; it is dependent upon its transportation and communication links. The city and its LIS are a "pivot point" between North America and Asia, unlike many of the other high-tech cluster areas in Canada and the US. Its major continental competition is in California, which has similar geographical attributes.

There are other strong LIS systems on the Pacific rim, "city-states" such as Singapore, Hong Kong, Sydney, and some large Chinese port cities, but only a very few (Busan, Korea for example) are gateways to larger systems of innovation. A few of them are currently or have been manufacturing centres, others are entrepot trade and financial centres (Hong Kong and Singapore) and two in particular; Vancouver and Sydney – interestingly both at extremes of the Pacific system are based on human capital activity. For all of its history and current development trajectories there is clearly something unique about innovation systems on the Pacific Rim? Is it likely that the behaviour of LIS on the Pacific Rim differ greatly

from LIS in continental North America or Europe, or for that matter other diverse economies such as India or inland China? Is it possible, that because of the distances involved, the Pacific system of innovation can be thought of being as a chain of local systems of innovation, with innovation gateways where continental lines of communication intersect the Pacific Rim?

Polèse (2009) has commented on the development of a second band of economic activity along the Pacific coast of North America (as opposed to the primary concentration along the Atlantic Seaboard), and has compared it to the lack of similar development in the Mediterranean:

"*The answer lies in the location – across the sea – of each continents principal trading partners. This is where we jump from a continental to a global perspective. The direction of international – intercontinental – trade influences the emergence of economic centres within each continent……..The West Coast of North America .found itself facing dynamic trading partners on the other side of the Pacific, beginning with the emergence of Japan….*".(Polese, 2009: 84,85)

Policy considerations

What then can policy makers derive from this evidence? It is clear that conventional innovation policy tools, such as support for R&D, are necessary, but not sufficient. The bio-pharma cluster in Vancouver certainly started through major bio-pharma R&D investments, but that by itself is not sufficient to explain its continued existence. Clearly conditions must also exist to attract and retain highly skilled workers (Florida's "super-creatives").

In Vancouver these conditions exist: the natural setting is spectacular, but also the various levels of government have combined to provide infrastructure and amenities that above many in North America.. The Economist Intelligence Unit regularly rates Vancouver as one of the most desirable places to live in the world. The infrastructure includes significant investment in mass transit, airports, hospitals, schools, and universities. But government policies have also favoured the development of significant cultural and recreational amenities: theatres, galleries, sports venues and green spaces. In the Canadian system of government many of these improvements fall to the city government. Both the City of Vancouver and Metro Vancouver (the regional government) have contributed directly to the development of the Vancouver LIS.

Vancouver's clusters increasing are benefiting from both the market demand and the cross-fertilisation possible from the presence of Hollywood North. Further the individual cluster stories have been shown to have benefited from industry associations providing some of the needed social capital for clusters that are fragmented and dominanted by small enterprises to to continue to seek and develop new opportunities (Petrusevich 2005 and Reibling 2004).

But the evidence on the history of the clusters – replicating by means of entrepreneurial spin-offs from earlier firms suggests very specific policies for innovation. Experience appears to matters to a very significant degree. In such an environment that is always likely to loose larger businesses and research / manufacturing endeavours to more central places encouraging a system of mentoring and experience needs significant policy focus. While it is difficult to generalize, the specifics of the Vancouver case indicate that clusters with low critical mass and distant from mega-regions appear to have particular dynamics. Firms seem to struggle to grow to any size and there is significant turning over of businesses and staff. Thus, the opportunities lie with speeding up the learning process for new graduates through fostering greater opportunities for experience.

Summary and Conclusion

This paper is an attempt to both integrate literatures on national urban systems and innovation as well as the 'geographical turn' in economics with its emphasis on the particularity of place, which as Martin notes has its origins in Losch: 'If everything occurred at the same time there would be no development. If everything existed in the same place there could be no particularity. Only space makes possible the particular which then unfolds in time' (quoted in Martin 1999: 66). The former is needed as the latter (particularity) has increasingly squeezed out of economic geography and innovation studies a sense of asking questions on the larger distribution of technological and innovation clusters. However, the important literatures in bringing the macro and the particular together do not necessarily sit well together. The rapidly expanding research exploring MAR-Jacobs (industry specialisation versus diversity) relationships is valuable for differentiating sectoral and city characteristics but little of the work incorporates city systems. The recent new economic geography promoted by Krugman and others has some useful mathematical modeling of agglomeration and thus centripetal and centrifugal forces but empirical testing of the models seems limited and is quite problematic when it comes to innovation.

Innovation policy in Canada is driven by the linear nature of European settlement across the country. Most innovation policy initiatives focus on the concentration of manufacturing enterprises in southern Ontario, and to a lesser extent, southern Quebec. The unique situation of Vancouver in Canada (Halifax, Vancouver's counterpart on the Atlantic coast, simply does not have the same order of magnitude of innovative activity as Vancouver). This suggests that unique innovation polices need to be developed for Vancouver and its hinterland, in the context of its participation in the two dimensional array of local innovation systems around the Pacific Rim. What might they be?

What are Vancouver's competitive advantages in a Pacific context? Vancouver benefits from being part of Canada – a Westminster-style democracy with well es-

tablished, and prudent legal and financial systems. It is seen as a haven for entrepreneurs around the Pacific, a place where they can store the fruits of their enterprise. Similarly it has the advantage of having an educational system that is based on English systems and which uses English as its language of instruction. Foreign students form an important component of both secondary and post-secondary education (and bring in significant revenues, since they pay premium fees). All of this suggests that innovation policy for Vancouver should focus on infrastructure, both physical (traditional as well as education and research related) and intangible. Governments, both local and national can and should invest to maintain Vancouver's growth, and to ensure that the gains made to date do not atrophy.

In an archipelago of cities mobility is harder (economic costs and loss of social networks), choices are fewer, and the local / regional innovation system interface is different. In such an economy the key cities become more important than the industries in them. The quality of life and economic opportunities for people across a wide range of economic groups is crucial. The implications of this in Canada is that the country does not need regional policies – i.e. western Canada is not like central Canada but that a federation with the geographic spread and diversity such as Canada needs a radically different policy framework. Instead of the Canadian federal focus on the creation of 'new industries' it is time to start thinking about a regional cities development fund.

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References

Acs, Z., de la Mothe, J., Paquet, G., (1996), Local systems of innovation: in search of an enabling strategy, in Howitt, P. (ed), The Implications of Knowledge-Based Growth for Micro-Economic Policies, The University of Calgary Press.

Andersson, T., Serger, S.S., Sorvik, J., and Hansson, E.W.,(2004) "The Cluster Policies Whitebook", International Organization for Knowledge Economy and Enterprise Development, Malmo

Antonelli, C. (2000), Collective knowledge communication and innovation: the evidence of technological districts, Regional Studies, Vol. 34 No. 6.

Asheim, B. and Isaksen, A. (2001), Regional Innovation Systems: The Integration of Local Sticky and Global Ubiquitous Knowledge, Journal of Technology Transfer.

Barnes, T.J. (2003) 'What's wrong with American regional science? A view from science studies' Canadian Journal of Regional Science, 26: pp3-26.
BC Film Commission (2009) British Columbia Film Commission production statistics 2008.
BC Stats (1999) Small Business Quarterly.
Beaudry, C. and Schiffauerova, A. (2009) "Who's right, Marshall or Jacobs? The localization versus urbanization debate" Research Policy 38 (2) 318–337.
Beckstead, D. and Brown, M. (2004) From Labrador City to Toronto: The industrial diversity of Canadian cities, 1992-2002 Statistics Canada Catalogue no. 11-624-MIE — No. 003
Boreham, P.R, Clegg, S.R. Emmison, J.M., Marks G.N., and Western J.S. (1989) 'Semi-Peripheries or Particular Pathways: The Case of Australia, New Zealand and Canada as Class Formations' International Sociology Vol 4(1): 67-90.
Bowden, J. (2000) "Airline hubs in Southeast Asia: national economic development and nodal accessibility" Journal of Transport Geography , Vol. 8
Bunnell T , Coe N (2001) 'Spaces and scales of innovation' Prog Hum Geogr 25 (4) : 569 – 589
Carlson, B., (2006) "Internationalization of innovation systems: A survey of the literature", Research Policy 35 (1), 56-67.
Center for International Earth Science Information Network (CIESIN), Columbia University; and Centro Internacional de Agricultura Tropical (CIAT). 2005. Gridded Population of the World Version 3 (GPWv3): Population Grids. Palisades, NY: Socioeconomic Data and Applications Center (SEDAC), Columbia University. Available at http://sedac.ciesin.columbia.edu/gpw. Image from TerraViva SEDAC Viewer.
Christaller, W, (1966), *Central places in Southern Germany / Walter Christaller;* translated by Carlisle W. Baskin Prentice-Hall, Englewood Cliffs, N.J.
Christopherson, S. and Storper, M. (1986) 'The city as studio; the world as back lot: The impact of vertical disintegration on the location of the motion picture industry' Environment and Planning D; Society and Space, Vol 4, pages 305-320.
Clayman, B. P. & J.A.D. Holbrook (2004), "Surviving spin-offs as a measure of research funding effectiveness", CPROST report 04-03
Coe, N. (2001) "A Hybrid Agglomeration? The Development of a Satellite-Marshallian Industrial District in Vancouver's Film Industry" Urban Studies Vol 38 (10) 1753-1775
Cooke, P. (2001) 'Regional Innovation Systems, Clusters, and the Knowledge Economy', Industrial and Corporate Change 10 (4): 945-974
Cooke, P., (1998), Introduction: Origins of the concept, in Braczyk, H-J., Cooke, P. and Heidenreich, M. (ed), Regional Innovation Systems – The Role of Governances in a Globalized World, UCL.
DeBresson C (ed) (1996) Economic interdependence and innovative activity an input-output analysis. Edward Elgar, Cheltenham.
Desrochers, P. and Hospers, G-J. (2007) 'Cities and the economic development of nations: An essay on Jane Jacobs' contribution to Economic theory', Canadian Journal of Regional Science. Vol 30 (1): 115-130.
Edquist, C. [ed.] (1997a) Systems of Innovation: Technologies, Institutions and Organisations. London: Pinter.
Florida, R.L. (2002) The Rise of the Creative Class. Basic Books, New York
Freeman C (1995) The 'national system of innovation' in historical perspective. Cambridge J Econ Vol 19 (1) : 5 – 24.Frey, B.S, and Pommerehne, W.W. (1984) 'The Hidden Economy: State and Prospects for Measurement' Review of Income and Wealth Vol 30 (1): 1-23
Gasher, M (2002) Hollywood North: The Feature Film Industry in British Columbia. Vancouver: University of British Columbia Press.
Gertler, M. (2001), "Tacit knowledge and the economic geography of context or The undefinable tacitness of being (there)", paper presented at the Nelson and Winter DRUID Conference, Aalborg, Denmark, June 2001.
Gertler, M.S., R. Florida, G. Gates, and T. Vinodrai, (2002), "Competing on Creativity: Placing Ontario's Cities in North American Context," see : www.competeprosper.ca.

Glaeser, E., Kallal, H.,Scheinkman, J., and Schleifer, A., (1992) "Growth in cities", Journal of Political Economy, 100, 1126-1152

Harrison, B. (1994) 'The Small Firms Myth' California Management Review. Vol. 36 (3):142-158.

Harrison, Chris. World Internet Connections: City-to-City. Digital. 2007: http://www.chrisharrison.net/projects/InternetMap/ accessed 27 September 2010.

Holbrook, J.A.D. (2006) "Regional Differences in Innovation in Knowledge-based Industries", International Journal of Technology, Knowledge and Society, Vol 2 (4): 153-162.

Holbrook, J.A.D. and Wolfe, D.A. (2005) "The Innovation Systems Research Network (ISRN): A Canadian Experiment in Knowledge Management", Science and Public Policy, Vol. 32, #2

Holbrook, J.A.D. and Wolfe, D.A. (eds.) (2000) "Innovation, Institutions and Territory: Regional Innovation Systems", McGill-Queen's University Press, Kingston, 2000, ISBN 0-88911-891-4

Holbrook, J.A.D., Arthurs, D., Cassidy, E. (2010) 'Understanding the Vancouver Hydrogen and Fuel Cells Cluster: A Case Study of Public Laboratories and Private Research' European Planning Studies, 18: 2, 317—328.

Ingram, M. (1997) Mike Brown, three guys and a garage The Globe and Mail January 27, 1997 Monday. Pg. B2

Klepper, S. (2001) 'Employee Start-ups in High-Tech Industries'. Industrial and Corporate Change Vol 10 (3): 639-674.

Langford, C., Li, B. And Ryan, C. (forthcoming) 'Innovation from an oil and gas platform: Calgary'.

Lundvall B-A (ed) (1992) National systems of innovation: towards a theory of innovation and interactive learning. Pinter, London.

Malmberg, A. and Maskell, P. (2001), "The elusive concept of localization economies - Towards a knowledge-based theory of spatial clustering", paper for "Industrial Clusters Revisited: Innovative Places or Uncharted Spaces", AAG Annual Conference, New York .

Markusen, A. (1999) 'Fuzzy concepts, scanty evidence, policy distance: the case for rigour and policy relevance in critical regional studies' Regional Studies, Vol. 33 (9): 869-884.

Martin, R. (1999) 'The new 'geographical turn' in economics: some critical reflections' Cambridge Journal of Economics Vol 23 (1): 65-91

Maskell, P. and Lorenzen, M. (2004) 'The Cluster as Market Organization' Urban Studies, 41 (5/6): 991–1009.

Milner. B. (1988) 'BCE Mobile bid for MDI Mobile remains $9.75' The Globe and Mail, April 21, 1988.

Natural Resources Canada (1957) Atlas of Canada 3rd Edition http://atlas.nrcan.gc.ca/site/english/maps/archives/3rdedition/economic/transportationandcommunications/088 viewed 23 February 2009.

Nauwelaers, C., and Reid, A., (1995) "Innovative Regions? A Comparative Review of Methods of Evaluating Regional Innovation Potential". European Innovation Monitoring System (EIMS) publication no. 21. Luxembourg: European Commission, Directorate General XIII.

Nelson RR (ed) (1993) National innovation systems: a comparative analysis. Oxford University Press, New York.

New York Times (1991) 'Company News; Electronic Arts To Buy Distinctive' New York Times June 18, 1991.

Nordhaus, W. (2006) 'Geographically based economic data' http://gecon.yale.edu/research-papers accessed August 2010. open access file.

O'Connor, K. (2003) "Global air travel: toward concentration or dispersal?" Journal of Transport Geography 11 pp 83–92.

O'Connor, K. and Scott, A., (1992), "Airline services and metropolitan areas in the Asia-Pacific region 1970- 1990", Review of Urban and Regional Development Studies, Vol 4 (2): 240 - 253

OECD (1997) National Innovation Systems, OECD, Paris.

OECD (2006) Competitive Cities in the Global Economy. Paris, OECD.
Oinas P , Malecki E (2002) 'The evolution of technologies in time and space: from national and regional to spatial innovation systems ' Int Reg Sci Rev 25 (1) : 102 – 131
Panik, F. (1998) 'Fuel cells for vehicle applications in cars – bringing the future closer', Journal of Power Sources, Vol 71 (1)36-38.
Petrusevich, M.R. (2005) *Social Capital Generators? A Case Study of Industry Associations within the Vancouver New Media Cluster*. Unpublished thesis Master of Arts in the School of Communication, Simon Fraser University. http://www.sfu.ca/cprost/theses.html
Phillips, P. 2002 Regional Systems of Innovation as a Modern R&D Entrepot: The Case of the Saskatoon Biotechnology Cluster. In J. Chrisman et al. (eds.), Innovation, Entrepreneurship Family Business and Economic Development: A Western Canadian Perspective. University of Calgary Press, pp. 31-58.
Polèse, M. and Shearmur, R. (2004) 'Is Distance Really Dead? Comparing Industrial Location Patterns over Time in Canada' International Regional Science Review 27 (4): 431-457.
Porter, M.E. (1998). "Clusters and the new economics of competition" Harvard Business Review. November December: 77-90.
Polèse,M. (2009), "The Wealth and Poverty of Nations", University of Chicago Press, Chicago, USA
Porter, M.E., (1990), "The Competitiveness of Nations", Macmillan, London
Pred, A. (1977): City Systems in Advanced Economies. London: Hutchinson.
Reibling, S.L.R (2004) Measuring 'High Tech' Social Capital in the Biotechnology Cluster Located in Vancouver, British Columbia. Master of Arts in the School of Communication, Simon Fraser University. http://www.sfu.ca/cprost/theses.html
Rodrigue, J-P., Comtois, C.and Slack, B. (2009) *The Geography of Transport Systems 2nd ed)*. New York: Routledge
Sharif, N. (2006) 'Emergence and Development of the National Innovation Systems Approach' Research Policy Vol 35 (5): 745-766.
Spanner, D. (2003) Dreaming in the rain: How Vancouver Became Hollywood North by Northwest. Vancouver, Arsenal Pulp Press.
Statistics Canada (2006) Survey of Innovation 4218: Definitions, data sources and methods http://www.statcan.gc.ca/cgi-bin/imdb/p2SV.pl?Function=getSurvey&SDDS=4218&lang=en&db=imdb&adm=8&dis=2
Wallerstein, I. (1976) 'Semi-Peripheral Countries and the Contemporary World Crisis' Theory and Society, Vol. 3 (4):. 461-483.
Wixted, B., (2009) Innovation System Frontiers: Cluster Networks and Global Value. Berlin, Springer.
Wixted B. and Holbrook, J.A.D., (2010), "Living on the Edge; Emerging Human capital intensive Clusters in Vancouver" in press
Wixted, B. (forthcoming) 'Configurations of Global Factories: The Role of Product Decomposability and Architectural Control'.
Wolfe, D.A., and Bramwell, A. (2008) Innovation, creativity and governance: Social dynamics of economic performance in city-regions. Innovation: Management, Policy & Practice 10 (2-3): 170–182.
Yeung, H. W-C (2005) 'Rethinking relational economic geography' Transactions of the Institute of British Geographers. Vol 30 (1): 37-51.